LonWorks™ Interoperability Guidelines

Version 1.0

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Introduction

LONWORKS nodes communicate with each other via the LONTALK™ protocol that is implemented in firmware on the NEURON® CHIP™. The LONTALK protocol offers the first real opportunity for products made by different manufacturers to interoperate. To meet the objective of supporting applications in a wide range of industries, the LONTALK protocol is presented as a collection of services that the designer selects. The LONWORKS interoperability guidelines provide direction to the designer on which selections to make and what values to use to enable interoperability between LONWORKS products.

These guidelines are the basis for obtaining the LONMARK™ logo, which indicates a product is LONWORKS interoperable. Products that apply to carry the LONMARK will be tested to verify that the product has been designed according to these guidelines.

Implementing the Interoperability Guidelines

LONWORKS products are designed using NEURON CHIPs and communicate with other LONWORKS products through the LONTALK protocol. The interoperability guidelines outline specific selections to make at each layer of the LONTALK protocol. Some of these selections are made within the LONBUILDER software, others through statements in the NEURON C application code and others refer to specific hardware that should be used.

LONWORKS products may be implemented as open or closed systems. Interoperability guidelines are provided to address each of these classes of products.

LONTALK Protocol Overview

The basis for interoperability is the LONTALK protocol. The LONTALK protocol follows the reference model for open systems interconnection (OSI) developed by the International Standard Organization (ISO). In the terminology of the ISO, the LONTALK protocol provides services at all 7 layers of the OSI reference model as summarized in Table 1-1.

The interoperability guidelines for the Physical layer and the Application layer are the most detailed since these are the layers that provide the LONWORKS developer with the most design flexibility. At the Physical layer these guidelines provide direction on hardware options for transceivers. At the Application layer, guidelines are provided on how to configure the product and handle the interoperable interface between the product and the interoperable network. The guidelines for layers 2-6 are primarily focussed on specific settings that should be set and stored within the NEURON CHIP to ensure that messages are sent in the correct format and adequate buffer space is allocated.

For more information on the LONTALK protocol please refer to the Echelon Engineering Bulletin entitled *The LONTALK Protocol (005-0017-01).*

Table 1-1. LONTALK Protocol Layering

	OSI Layer	Purpose	Services Provided
7	Application	Application Compatibility	Standard Network Variable Types
6	Presentation	Data Interpretation	Network Variables Foreign Frame Transmission
5	Session	Remote Actions	Request-Response Authentication Network Management
4	Transport	End-to-End Reliability	Acknowledged & Unacknowledged Unicast & Multicast Authentication Common Ordering; Duplicate Detection
3	Network	Destination Addressing	Addressing Routers
2	Link	Media Access and Framing	Framing, Data Encoding; CRC Error Checking Predictive CSMA; Collision Avoidance; Optional Priority & Collision Detection
1	Physical	Electrical Interconnect	Media-Specific Interfaces and Modulation Schemes (twisted pair, powerline, radio frequency, coaxial cable, infrared, fiber optic

LONMARK™ logo

Products that are designed according to these interoperability guidelines may qualify to carry the LONMARK logo on the product to indicate the product is LONWORKS interoperable. Administrative Guidelines outlining the procedure for applying for the LONMARK logo will be available 6/92 from Echelon.

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Physical Layer

The LONTALK protocol supports networks with segments using differing media, including twisted pair, powerline, radio frequency, infrared, coaxial cable, and fiber optics. Every LONWORKS node is physically connected to a channel which is a physical transport medium for message packets. The physical form of a channel depends on the medium. For example, a twisted pair channel is a twisted pair of wires; an RF channel is a specific radio frequency; a powerline channel is a contiguous section of AC power wiring. The data rate of a channel is dependent upon the transceiver design.

The fundamental issue to be resolved in order for LONWORKS products made by different manufacturers to interoperate, is that electrical network interconnection between the products is possible. The transceiver design plays an important role in allowing nodes on a channel to interoperate reliably and predictably.

To facilitate and promote interoperability, the LONWORKS interoperability guidelines provide transceiver designs for a variety of media. These transceiver designs must be used as the physical layer for interoperable LONWORKS nodes. Using these designs is a requirement for the LONMARK program. The first physical channels supported by documented designs are listed in Table 2-1.

Table 2-1 Interoperable Physical Channels

Physical Channel	Medium	Data Rate	Other
TP 1.25 Mbps	Twisted Pair	1.25 Mbps	Transformer Coupled
TP 78 Kbps	Twisted Pair	78 Kbps	Transformer Coupled
RS485	Twisted Pair	39 Kpbs	EIA RS-485

For each physical channel, details of the transceiver design that should be used, including schematics and parts lists, are provided. The LONTALK communication channel parameters for each transceiver are specified in the Layer 2 guidelines. These parameters must be set to ensure that all nodes on a channel will interoperate without requiring parameter adjustment prior to installation.

Additional transceivers will be added as market requirements demand. The criteria used in deciding to adopt a transceiver design include:

- Is this transceiver design thoroughly tested?
- Is this design open and publically available?
- Does this transceiver have long term, wide spread applicability?

Products designed using a non-interoperable transceiver can be used in an interoperable network usi a router, however all other interoperability guidelines still apply. This option is described in the Application Layer guidelines in Chapter 4.

Transformer-coupled Twisted Pair Transceiver Design

Performance Specification

Table 2-2 provides a summary of the performance specifications that must be met by nodes designed for the 78 Kbps and 1.25 Mbps transformer coupled twisted pair channels.

Table 2-2 Performance Specification for Transformer-coupled 78 Kbps and 1.25 Mbps Twisted Pair channels.

Performance Specification	TP 78 Kbps	TP 1.25 Mbps
Transmission Speed	78 Kbps	1.25 Mbps
Nodes per Bus	64	64
Network Bus Wiring	UL Level IV, 22 AWG twisted pair	
Network Bus Length - typical (20°C)[1] -worst case[2]	 2000m 1330m	 500m 125m
Maximum Stub Length[3]	3m	0.3m
Network terminators	Required at both ends of the network	

[1] Typical conditions are detailed in the section on performance testing.

[2] Parameters that must be considered for evaluating worst case performance are detailed in the section on performance testing that follows.

[3] The stub length in Table 2-2 assumes a mutual capacitance of 17 pF/ft (56 pF/m) for the twisted pair stub cable.

For a product to carry the LONMARK logo it must be demonstrated that the product meets the performance specifications as shown. Please refer to the section on physical layer performance testing for information on additional performance information that must be provided.

Guideline: Specified transceiver schematics must be followed exactly

The schematics for the twisted pair transformer coupled designs are shown in Figures 2-1 and 2-2. These are the same designs that are implemented in Echelon's TP/XF-1250 and TP/XF-78 twisted pair modules. Unless otherwise noted, the following ratings apply to all devices.

Capacitors	5%	NPO	50V	ceramic
Resistors	1%	100PPM per °C	1/8 watt	metal film
Inductors	5%			

Transformers

Guideline: Use only the specified transformers

The specified transfomers are designed to provide the optimal isolation, drive, and impedance:

Transformer	TP 78 Kbps	TP 1.25 Mbps
Part Number	PI 0505-0542	PE 65948
Turns Ratio	2:1	1:1
Magnetic Inductance	40 mH	4.0 mH
Supplier	Precision Components Inc. 710 Western, Suite B Lombard, IL 60148	Pulse Engineering Inc. PO Box 12235 San Diego, CA 92112
Contact	Bill Gray (708) 543 6484	John Schuler (619) 674 8100

Power-Down Relay

Guideline: A 5 volt normally-open electromechanical relay having a contact-to-coil capacitance not exceeding 4 pF must be used.

The power down relay (open when not powered) provides a high impedance to the twisted pair bus and protects the network if the node loses power. A 5 volt normally-open electromechanical relay having a contact-to-coil capacitance not exceeding 4 pF must be used. The 5 volt supply to the relay must be the same 5 volt supply used to power the NEURON CHIP.

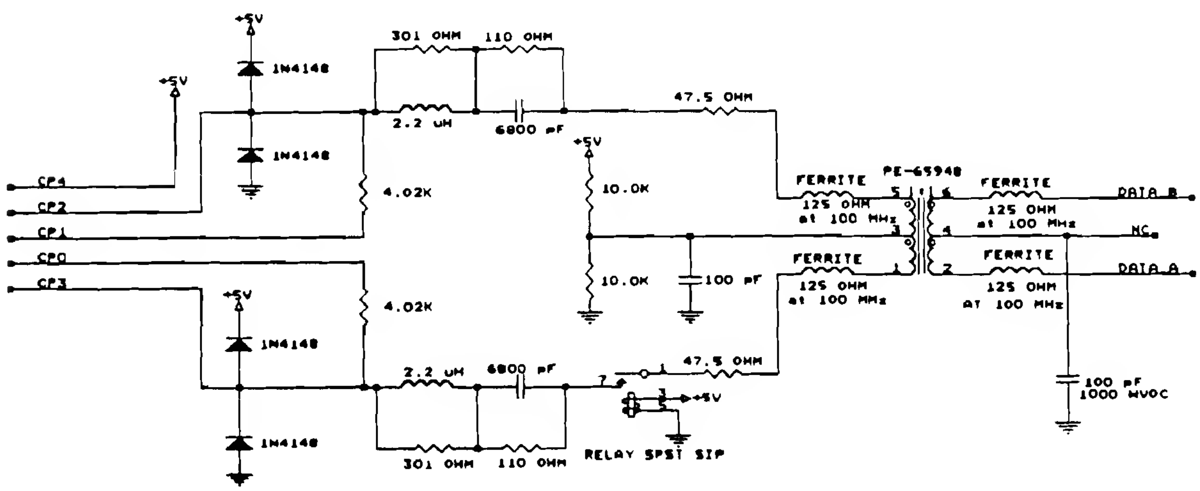


Figure 2-1 Transformer-coupled 1.25 Mbps Twisted Pair Transceiver

Note: The 75 Ω resistors are to be used when the 150μH inductor has a DCR <6Ω. 64.9 Ω resistors should be substituted when the 150μH inductor DCR >6Ω

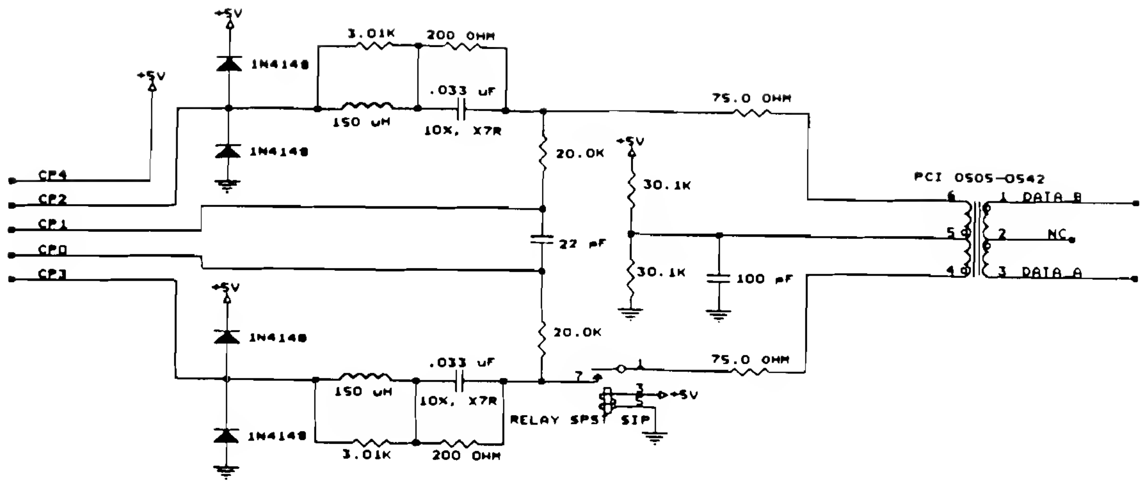


Figure 2-2 Transformer-coupled 78 Kbps Twisted Pair Transceiver

Layout Considerations

Minimizing Capacitance

The transceiver parasitic capacitances relate directly to bus loading and topological limits. Therefore, all parasitic capacitances must be minimized through the use of carefully designed layout using gridded ground planes and short trace runs. In general, the total capacitance from all combined traces to ground (or to another trace) must be minimized.

Symmetry

The NEURON CHIP uses a symmetrical differential drive and detection system. Therefore, symmetrical analog layout rules should be used.

Power Supply and Noise Considerations

Node power supply design must consider the filtering and decoupling requirements of the node. The power supply filtering and decoupling must prevent noise generated by the node and I/O circuit from degrading channel performance

or conducting noise through any external path. Particular care must be taken with switching power supplies.

Network Cabling and Connection

Network Cable

Guideline: Use UL Level IV, 22 AWG twisted pair cable

The characteristics of the wire used to implement a network will affect the overall system performance with respect to total distance, stub length, and total number of nodes supported on a single channel. The network performance is characterized for UL level IV, 22 AWG twisted pair cable as defined in document: *UL's LAN Cable Certification Program, Document number 200-120 20M/11/91.*

Bus Termination

Guideline: Use specified termination circuit

It is necessary to terminate the ends of a twisted pair bus to minimize reflections. Failure to terminate the bus will degrade network performance. Figure 2-3 details the circuit required to terminate the TP 1.25 Mbps and TP 78 Kbps physical channels.

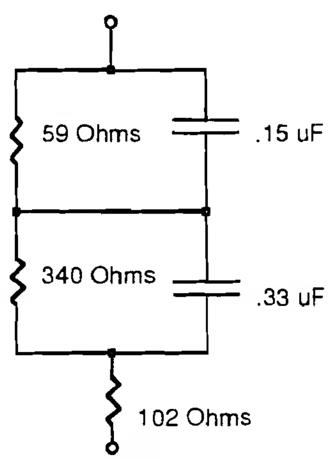


Figure 2-3 Bus Termination Circuit for TP 1.25 Mbps and TP 78 Kbps

The following rated devices should be used.

Component	Type	Rating
Resistors	Metal Film	1%
Capacitors	Polyester	0%

RS-485 Transceiver Design

Overview

The RS-485 transceiver uses transceivers that support the EIA RS-485 specification. RS-485 transceivers operate from +5V, provide -7V to +12V common-mode range and offer short circuit protection and a high impedance output in the event of a local power failure. The RS-485 standard allows for a continuum of bit rates, however, 39 Kbps is the bit rate required to interoperate on a LONWORKS RS485 channel.

Performance Specifications

The performance specification that must be met by nodes designed for the RS-485 channel is summarized in Table 2-3.

Table 2-3 Performance Specification for RS-485

Performance Specification	RS-485
Transmission Speed	39 Kbps at listed bus length
Nodes per Bus [1]	32
Network Bus Wiring	UL Level IV, 22 AWG twisted pair
Network Bus Length	1200m per EIA RS-485 standard
Maximum Stub Length [1]	0 m
Network Terminators	Required at both ends of network

1 These are EIA RS-485 Standards detailed in the EIA RS-485 Specification Section 3. entitled Electrical Characteristics.

Transceiver Schematic

Guideline: Specified transceiver schematics must be followed exactly

The schematic for the RS-485 transceiver design is shown in Figure 2-4. This is the same design that is implemented in Echelon's TP-RS485 twisted pair modules. Unless otherwise noted, the following ratings apply to all devices on the schematic.

Component	Type	Rating		
Resistors	metal film	1%	100PPM per °C	1/8 watt

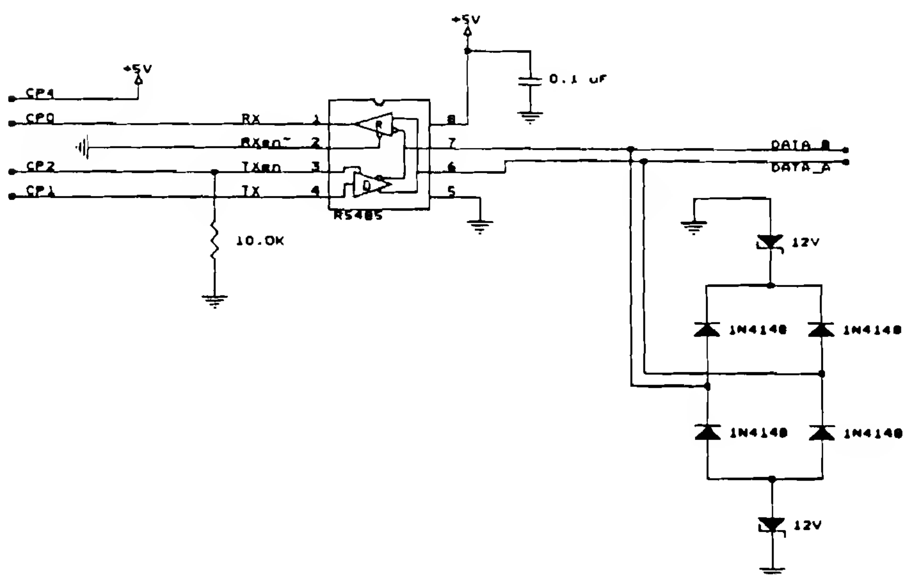


Figure 2-4 RS485 Transceiver

Bus Termination

Guideline: Use specified termination circuit or TP 78 Kbps and TP 1.25 Mbps terminator

It is necessary to terminate the ends of a twisted pair bus to minimize reflections. Failure to terminate the bus will degrade network performance. Figure 2-5 details the circuit required to terminate the RS485 physical channel. The TP 78 Kbpsand TP 1.25 Mbps termination circuit may be substituted.

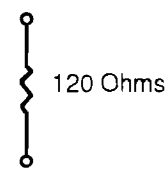


Figure 2-5 Bus Termination Circuit for RS485

EIA Standard RS485

Guideline: RS485 nodes must comply with the grounding requirements of the EIA RS485 Standard detailed in the EIA RS485 Specification Section A.3 entitled Optional Grounding Arrangements

A signal return path between the circuit grounds of nodes on a RS485 network must be provided. The ground reference may be established by a third conductor or by providing a connection to an earth reference at each node .

Physical Layer Performance Testing

General

Responsibility for providing performance specifications and supporting test data lies with the manufacturer. Many of the specifications that are requested to support the LONMARK submittal are based on the need for each node to act as a *good citizen* ie. does not create any interference that would inhibit producst from interoperating on a physical media.

Distance

Typical and worst case distance specifications are required to support a product submitted for the LONMARK logo.

Typical Conditions

Typical Conditions are 20^{0} C, normal wire temperature and 64 evenly distributed nodes.

Worst Case Conditions

Worst case conditions must take into consideration the combined effect of worst case conditions of all of the following parameters:

Parameter	**Worst Case Conditions** **TP 78 Kbps**	**TP 1.25 Mbps**
Node distribution	all distributions	all distributions
Number of nodes	64	64
Stub length	3m	0.3m
Node supply voltage	4.75 - 5.25 V	4.75 - 5.25 V
Wire characteristics	refer to UL level IV 22 AWG wire specs	
NEURON CHIP comm port	Differential driver and differential receiver electrical characteristics specified in Section 12 of the NEURON CHIP Advance Information data sheet.	
Node Temperature	Full Range	
Wire Temperature	Full Range	

Guideline: *TP 78 Kbps and TP 1.25 Mbps based nodes under worst case conditions must meet or exceed the distance curves shown in Figure 2-6 or 2-7 .*

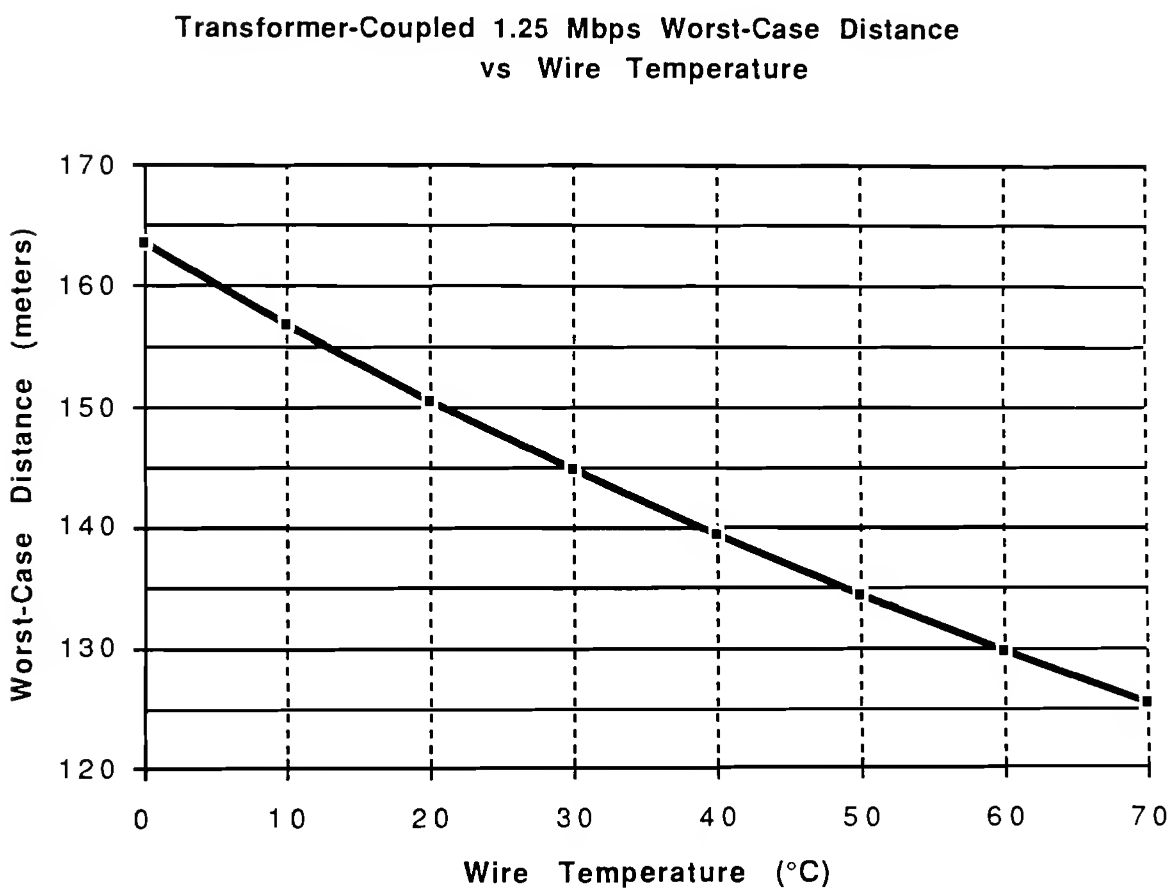


Figure 2-6 Distance Specification TP 1.25 Mbps Node

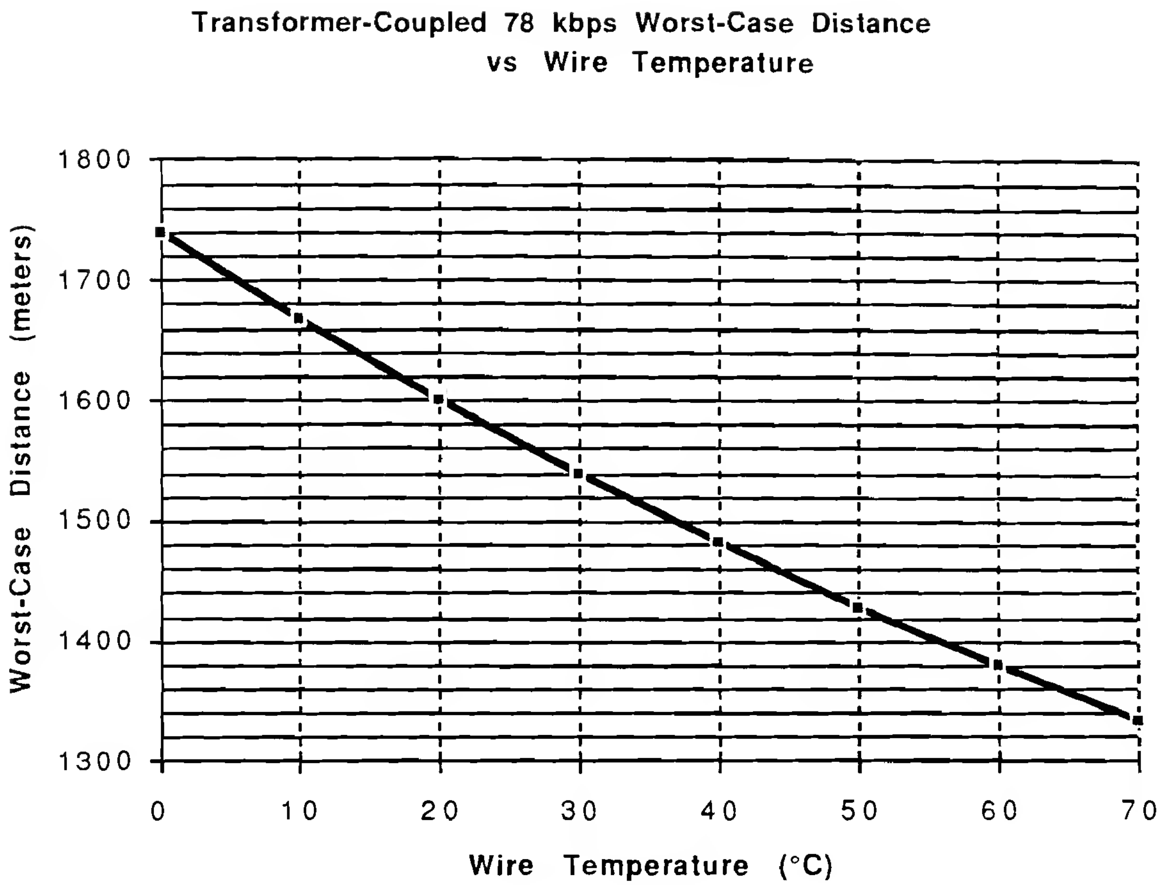


Figure 2-7 Distance Specification TP 78 Kbps Node

Input Impedance

The input impedance of a node on a network directly affects the number of nodes that can be supported on the channel. To ensure that nodes are good citizens the following guideline must be met.

Guideline: *The node impedance measured at the network connector must be within the bounds shown in Figures 2-8 or 2-9 over the whole frequency range.*

Transformer-Coupled 78 kbps Node Impedance

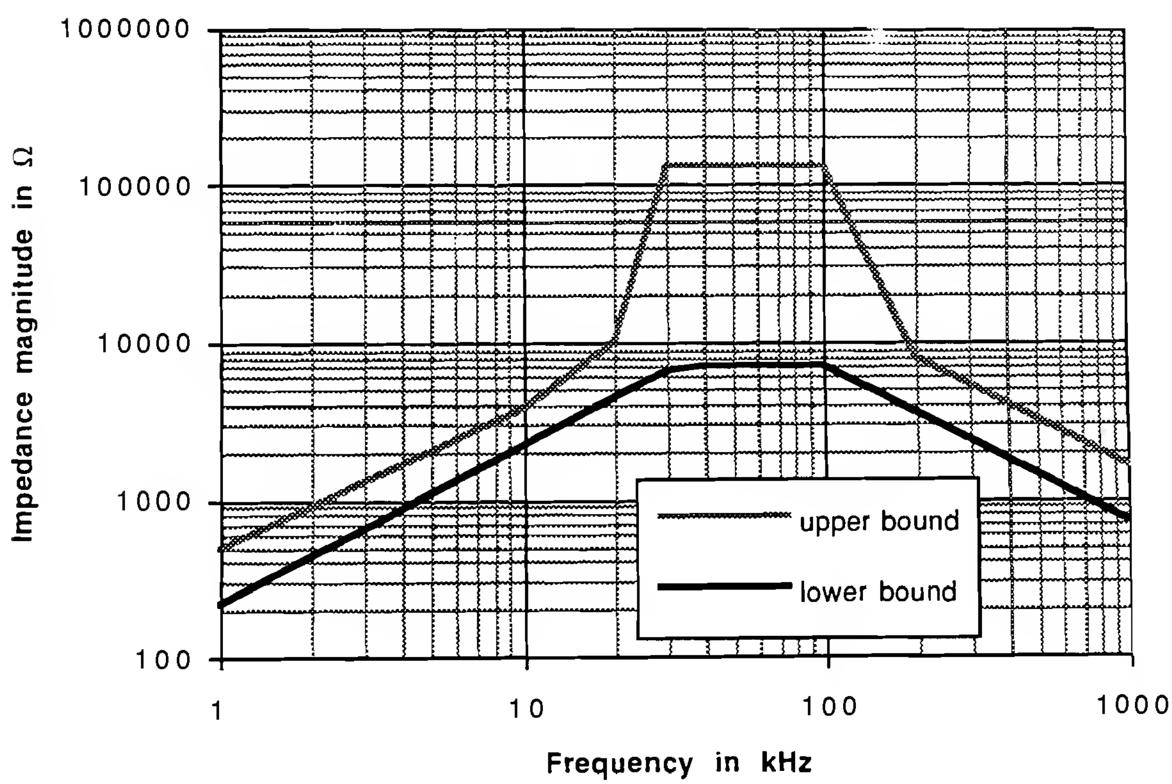


Figure 2-8 Node Impedance Specification TP 78 Kbps at 5.0 V and 23 °C

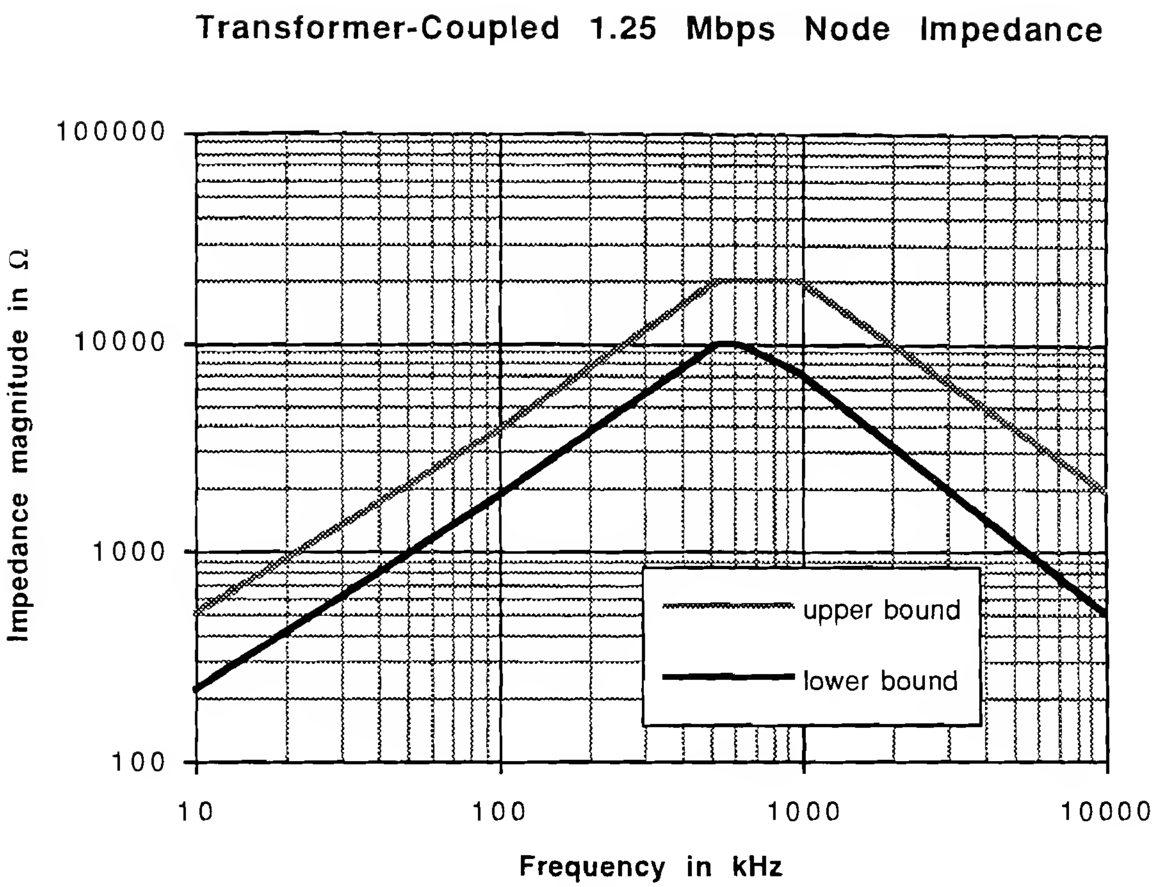


Figure 2-9 Node Impedance Specfication TP 1.25 Mbps at 5.0V and 23 °C

Electromagmetic Compliance (EMC)

Products submitted for the LONMARK logo are required to demonstrate compliance with EMI requirements of the markets they intend to serve. All submittals must make a declaration of the intended markets for the product and provide supporting test data to demonstrate compliance.

Additional Performance Specifications

The following data is required with all LONMARK submittals to ensure that all LONWORKS interoperable products are *good citizens*.

Electro Static Discharge (ESD)

Condition	**kV**	**test method**
No errors	*Data required*	
No hard failures	*Data required*	

Isolation

Condition	**V RMS**
0 - 60 Hz (60 seconds)	*Data required*
0 - 60 Hz (continuous)	*Data required*

Temperature

Condition	**Temperature**
Operating	*Data required*
Non-operating	*Data required*

Humidity

Condition	**Humidity (% RH)**	**Temperature (°C)**
Operating	*Data required*	20 °C
Non-operating	*Data required*	

3

Layers 2-6

The guidelines for Layers 2-6 of the LONTALK protocol are followed by making selections within the LonBuilder software and via pragma statements in the NEURON C application code. In addition to having the appropriate transceiver connected to the communication port of the NEURON CHIP there have to be appropriate channel settings present in the memory of the NEURON CHIP to enable the LONTALK protocol to send out messages in the correct format to allow interoperability.

The LONBUILDER development system has many default settings built-in, so at first you may not have to be concerned about entering the parameters described in these guidelines. However once development moves on to custom hardware then you will need to follow these guidelines to ensure interoperability.

Layer 2

Channel Parameters

Every LONWORKS node is physically connected to a communication channel via a transceiver, and has channel parameters stored in memory that define the communication hardware and configuration. The LONBUILDER system has default channel parameters, *default_channel,* which are appropriate for initial testing and debugging on the backplane network. However, to develop custom nodes, a physical channel has to be created and channel parameters defined within the LONBUILDER environment (refer to *Chapter 10 LONBUILDER User's Guide).*

The channel parameters used by nodes that share the same physical channel must agree in order for them to communicate. Deciding which channel parameters to use is a trade off between higher network throughput and lower cost components.

The NEURON CHIP communications port encodes and decodes data using Differential Manchester or bi-phase space coding. A *preamble* is transmitted at the beginning of a packet to allow the other nodes to synchronize their receiver clocks. An idle period called the *beta 1* time is provided after each packet to signify the end of a packet. Another important characteristic of a message is the *beta 2* time, which defines the width of the randomizing slots. The lengths of the preamble, beta 1 and beta 2 times are configurable by the LONWORKS designer independently of the transceiver design. In order for a set of nodes to interoperate, the channel parameters that control the preamble, beta 1 and beta 2 times must match.

Guideline: Specified channel parameters must be used

The correct channel parameters are loaded by making the following selections in the Channel Create screen of the LONBUILDER . Different fields need to be filled in depending on the transceiver type selected.

Table 3-1 Channel Parameters

Channel Parameters	**TP 78 Kbps and 1.25 TP Mbps**	**RS485**
Transceiver Type	Twisted Pair	Single-ended
Bit rate	78 Kbps or 1.25 Mbps	39 Kbps
Collision Detect	N/A	NO
CD Terminate after preamble	N/A	NO
CD through Packet End	N/A	NO
Bit Sync Threshold	N/A	4 bits

Guideline: Minimum acceptable oscillator frequency is indicated in Table 3-2

The LONTALK protocol supports interworking of nodes running at different clock speeds by lengthening the preamble to accommodate the slowest node. However, there is a penalty on network throughput associated with nodes running at slower speeds. This network performance penalty is shared by all nodes on the channel even by the nodes whose clocks run at the maximum clock speed of 10 MHz. In order to provide some flexibility but also sustain good network performance, all interoperable nodes must adhere to the following guidelines regarding minimum clock speeds.

Table 3-2 Minimum Clock Speed vs. Data Rate

Transceiver	**Minimum Oscillator Frequency**
TP 1.25 Mbps	10 MHz
TP 78 Kbps	5 MHz
RS4855	5 MHz

Guideline: An oscillator with an accuracy of 0.02% or better must be used

The oscillator accuracy directly affects the throughput of a physical channel by affecting the width of the priority and randomizing slots that may be supported. The accuracy of the oscillator has the largest effect on network throughput of all of the parameters discussed. In order to not degrade network throughput and also to support a reasonable number of priority slots per channel, all interoperable nodes must include an oscillator with an accuracy of at least 0.02 % over the complete temperature range that the node is specified to operate within. This means that crystals must be used rather than ceramic resonators.

Guideline: Priority Slots must be configured as shown in Table 3-3

All nodes sharing the same physical channel must be configured with the same number of supported priority slots in order that they can reliably exchange messages. Each priority time slot on a channel adds a minimum of two bit times to the transmission of every message. The amount of overhead associated with priority messaging varies based upon the data rate and oscillator accuracy and transceiver characteristics of nodes on the channel.

The LONTALK protocol permits a developer or user to optionally allocate priority time slots on a channel to nodes. The network management node that assigns priority slots to individual nodes can ensure that one and only one node is assigned to a particular priority slot on the channel. Because there is no contention for the media during the priority portion of a packet cycle, nodes configured with priority have better response time than non-priority nodes when the channel is heavily utilized.

Simple NEURON-based network management nodes can assign priority when the channel is already configured with priority slots. However, a LONMANAGER API-based network manager may be required to assign additional priority slots to a channel. For this reason it is required that a small number of priority slots (as indicated in Table 3-3) be assigned at manufacture to allow simple NEURON-based network management . The number of priority slots is kept small to minimize effects on throughput. By requiring a higher accuracy oscillator the effect of each priority slot on throughput is also minimized.

Table 3-3 Required number of priority slots

Physical Channel	Clock Rate	No. of priority slots
TP 1.25 Mbps	10 MHz	16
TP 78 Kbps	10 MHz 5 MHz	4
TP-RS485	10 MHz4 5 MHz	4

Network Buffers

The network I/O buffer sizes are configurable within the application program on a node via the use of NEURON C pragmas. There are three buffer sizes and counts to configure: network output buffers, network output priority buffers and network input buffers.

Guideline: Network input buffers must be sized for at least 66 bytes.

The network input buffers must be sized for at least 66 bytes to allow at a minimum sending the maximum size network variable.

Guideline: Network output buffers must be sized to accommodate the longest packet that the node can send.

Network output buffers must be large enough to send the longest packet that the node application can generate. This length includes not only the application information, but also the worst case addressing overhead for the packet. The default, set by the LONBUILDER is adequate and the formula calculation is in Table 6-1 of the *NEURON C Programmers Guide.*

Guideline: Priority network output buffers are necessary if the product can receive or send priority messages.

Network output priority buffers are needed if the node can be installed to use priority messaging. The same sizing and count rules apply for these buffers as for ordinary network output buffers. By using the *nonpriority nonconfig* declaration for network variables, and by not setting the priority field for explicit messages, you can ensure that no priority can be assigned.

Layer 4

Guideline: The receive transaction buffer pool must be sized to the LONBUILDER minimum default or greater. The formula for the default is given in Table 6-1 of the Neuron C Programmer's Guide.

A node with insufficient buffers will fail to receive messages.

Guideline: Acknowledged service is not permitted for packets requiring an output buffer greater than 66 bytes.

Acknowledged service is not permitted when the packet to be sent requires an output buffer greater than 66 bytes. The reason for this is that all nodes on a channel must receive every message in order to maintain the correct estimate of the channel backlog. If an incoming message is longer than the buffer allocated to hold it, the message will fail CRC and will be discarded prior to extracting the backlog information from it. Since unacknowledged packets always have a backlog increment of zero, there is no problem sending longer packets using one of the unacknowledged services provided by the LONTALK protocol.

All nodes must use unacknowledged protocol services when transmitting packets that require output buffers that are more than 66 bytes long.

4

Application Layer

The LONTALK protocol employs a data oriented application protocol. In this approach, application data items such as temperatures, pressures, states, text strings, and other data items are exchanged between nodes in standard engineering and other predefined units. The command functions are then encapsulated within the application programs of the receiver nodes rather than being sent over the network. In this way, the same engineering value can be sent to multiple nodes each of which have a different application for that data item.

The data items in the LONTALK protocol are called network variables. Network variables can be any single data item or data structure. Application writers need only declare these variables using the keyword *network,* and the variable will be available to any other node within the network. When *output* network variables change via assignment operations within the application program, the executive built into the NEURON CHIP firmware automatically propagates the new value over the network using LONTALK protocol services. This implicit messaging frees the application writer from buffer management, message initialization, message parsing, and error handling.

Application compatibility is facilitated through the use of Standard Network Variable Types, or SNVTs. The initial list of SNVTs covers a very wide range of applications. The definition of a SNVT includes units, a range, and a resolution. Using the appropriate network management commands, a LONWORKS node can extract the SNVT information (ID # and optional text string) from any other node. Currently defined SNVTS are listed in the *SNVT List*.

The Application Layer guidelines address the concept of an interoperable system, messaging services to be used and also some issues concerning network installation features.

Interoperable Systems

Products designed using LONWORKS technology can be viewed as systems comprising one or more LONWORKS nodes. In addition, products can be viewed as either closed or open systems. Closed system products keep the internal workings of the system concealed from the interoperable network.

Guideline: Closed Products that comprise more than one node must designate a node to be an interface node.

Closed products that contain more than one node, must assign a node to act as the interface node to the interoperable network, see Figure 4-1. The role of this node is to act as an agent for the product on the interoperable network. This node should be viewed as an additional node to the product, since it is not part of the control system within the product, but simply passes information to and from the interoperable network. This node will be assigned the standard node ID for the product.

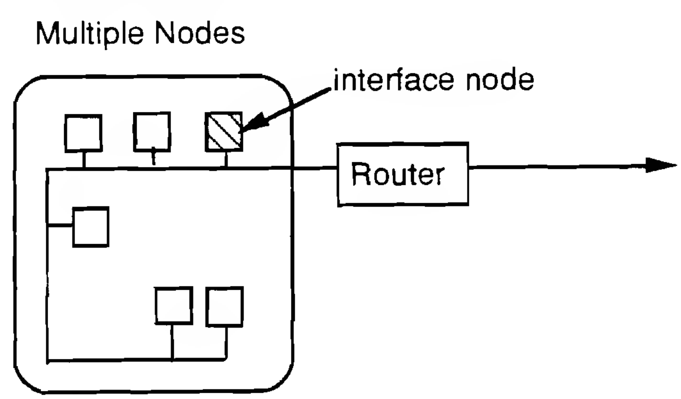


Figure 4-1 LONWORKS product configurations

From the perspective of the interoperable network a closed product is viewed as a single node, the interface node. This node will provide the interoperable interface that provides the SNVT connections that can be made between the network and this product. Any functions that are provided between the product and the interoperable network must be provided through the interface node.

There are two design options for protecting the integrity and privacy of the nodes within the product:

1) Assign all nodes within the network to a unique domain. All nodes but the interface node should have network management authentication enabled. The interface node must not have the authentication key for the internal domain assigned. The interface node should be configured for two domains, one domain to communicate with the nodes within the product and the other domain for the interoperable network. Since network management authentication is assigned for all product nodes but the interface node, none of the nodes within the product can be reconfigured, queried or bound from the interoperable network. Since the interface node does not carry the authentication key, the interoperable network cannot access the internal network by exploring the interface node.

2) Alternatively, an application gateway can be designed where the interface node is replaced by two NEURON CHIPs back-to-back. One NEURON CHIP participates in the product network and the other participates on the interoperable network. The two NEURON CHIPs communicate via parallel I/O. The NEURON CHIP on the interoperable network has complete control at the application layer to allow or deny access to the nodes within the product.

Guideline: *A Router is required between a product and the interoperable network when any of the following conditions exist:*

1) The nodes within the product do not communicate according to interoperability guidelines. One example of this is when the transceiver does not conform to the physical layer guidelines.

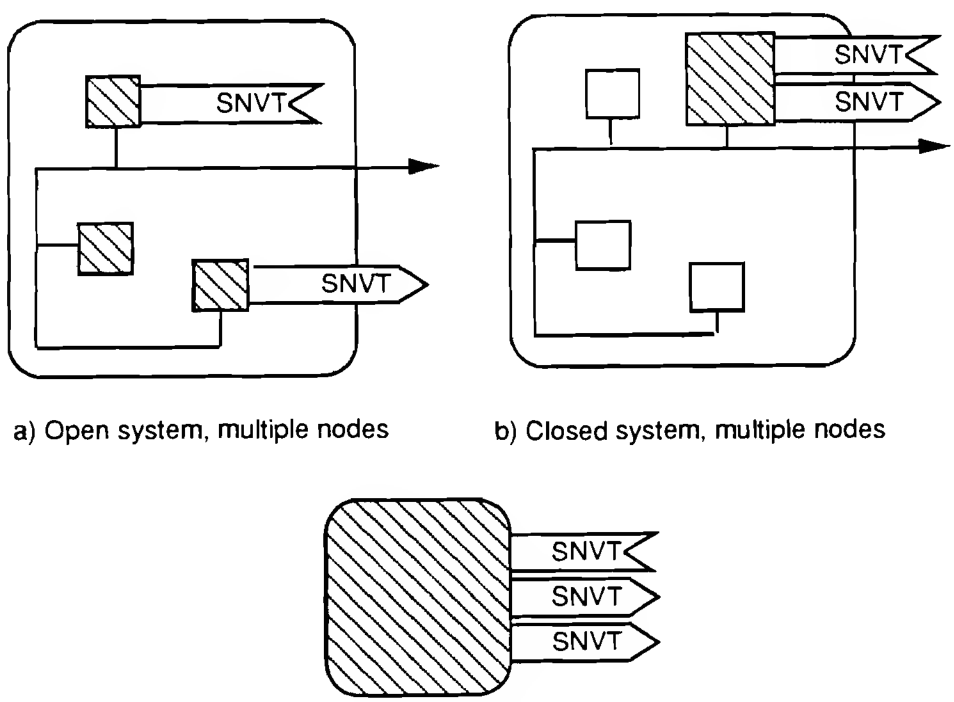
2) The integrity of the product would be adversely affected by traffic from the interoperable network.

3) The integrity of the interoperable network would be adversely affected by excessive traffic loading from the product (for example the product traffic already consumes a substantial portion of the bandwidth of the channel).

Messaging - Standard Network Variable Type SNVT Usage

Guideline: SNVTs must be used for interoperable communication

All messages that are intended to be sent between LONWORKS-based should use SNVTs. The LONTALK protocol ensures that network variables can only be connected to network variables of the same type. In addition the SNVT class of network variable establishes common definitions for data. This allows products made by different manufacturers to correctly interpret and exchange data. Although SNVTs *must* be used for interoperable communication, explicit messaging and addressing may be used *within* a LONWORKS product that comprises more than one node. Figure 4-2 illustrates interoperable communication using SNVTs for three classes of products: a product comprising a single node, and an open product and closed product comprising more than one node.



a) Open system, multiple nodes   b) Closed system, multiple nodes

c) Single Node

Figure 4- 2 Interoperable communication using SNVTs

To use a SNVT, data within the device must first be converted to the particular data definition of the SNVT andraw measurements must be appropriately linearized, calibrated and filtered. This allows one device to be interchanged for another because the different hardware characteristics are hidden from the network. For example, a thermistor-based temperature sensor can be interchanged with a thermocouple-based sensor as long as each of them generates a calibrated temperature of type *SNVT_temp*.

The available SNVTs are listed in the SNVT List attachment. This list will be augmented carefully to accommodate new requirements for standard data representations. All units are *Systeme Internationale* (SI) except as indicated. In general, the following considerations will be made when reviewing the adoption of new SNVTs:

1. Is this request applicable to more than one customer?
2. Are there any exisiting SNVTs that can be used to fulfill this request?
3. Is this a recognized standard data convention?

SI units will be used, except when the generally accepted industry convention worldwide is not in SI units.

All numeric (engineering measurement) SNVTs are represented in one or more fixed point types, using 8 or 16-bit signed or unsigned integers, with the appropriate choice of scaling factor. In addition there are also floating point types. The representation used in the LONTALK protocol is ANSI/IEEE 754 floating point: 1 sign bit, 8 exponent bits, and 23 mantissa bits, for a total of 32 bits. For all the floating point SNVTs, the range is approximately -1E38 to +1E38 units. Floating point objects may be declared as local variables and as network variables, and can be communicated across the network. A library of basic arithmetic operations is available for manipulating data expressed in floating point formats.

Data Transfer

In data logging and monitoring applications there is the need to be able to send files of data between nodes on a network. How the information within the file is interperted is determined by the user. The format of different file types such as time-based recordings, and event-based recordings with time stamps is not dictated by the LONTALK protocol. The role of the LONTALK protocol is to transmit information reliably from source to destination.

The main concern with data transfer on a control network is the impact of sending long data packets on the response time of the control application. The LONTALK protocol is optimized for control applications where the packets are typically 12 bytes in length.

The proposed method for data transfer on an interoperable network is currently under review.

Network Configuration

Overview

When designing a product for installation into an interoperable network, there are several guidelines that need to be followed in order for a third party to identify and connect a product correctly to the network. An installer needs to know what SNVT connections are available, how many, and what type. This information is needed to build up a database that describes the network.

Guideline: *One or more of the following must be provided to allow installation of the product:*

Self-identification and self-documentation

Self-identification and self-documentation information is written into read-only memory on the NEURON CHIP during node manufacture. The benefit of installing self-identification and self-documentation information is that a product can be installed into a network by simply reading this information over the network, no accompanying manufacturer documentation is needed. There are four structures associated with self-identification and self-documentation:

- a fixed size SNVT structure
- a table containing a self-identification descriptor for each network variable
- a self-documentation string for the node
- self-documentation information for the network variables

Descriptions of these self-identification tables and their usage are provided in Section A.5 of the *NEURON 3120 ™ CHIP and NEURON 3150™ CHIP Advance Information* data sheet.

External Interface file (.XIF file)

A node's external interface file (.XIF suffix) is automatically created by the LONBUILDER system. The .XIF file provides the node's connection information, in addition to hardware-related parameters, including the NEURON CHIP type, the clock rate, the bit rate, and the medium type. The file format consists of a number of records, one record per network variable or message tag, preceded by some header information and some global values for use by the network binder. The global values include the following information

- Standard Node ID
- Number of domains the node belongs to
- Number of address table slots
- Whether the node handles incoming explicit messages
- The number of network variable records
- The number of message tags defined

The .XIF file can be used by a network manager to allow connection to the node. A manufacturer can ship this file with the product or provide to the network manager manufacturer.

Product Documentation

If the product does not contain self-identification and self-documentation or an external interface file is not provided then all the information provided by these options must be documented and provided with the product.

Guideline: Maximum and average rate estimates must be provided

There are two extension records to the SNVT descriptor table that contain estimates of maximum and average message rates for each network variable. These extension records must be completed to aid in the installation of large networks where channel capacity is a consideration. Refer to the *NEURON 3120 CHIP and NEURON 3150 CHIP Advance Information Data Sheet* for detailed information.

If there are no extension records, rate estimates must be documented.

Guideline: Standard Node IDs assigned by Echelon must be installed.

There are three strings in EEPROM which together uniquely identify a specific LONWORKS device. The three fields are

NEURON CHIP ID (8 bytes) - this consists of 6 bytes for ID and two unused bytes which may be used for chip manufacturer ID. The NEURON CHIP ID is burned in by the chip manufacturer.

Program ID (8 bytes) - also known as Standard Node ID. This is intended to indicate device type. The string is stored along with the application program by the device programmer.

Location String (8 bytes) - this allows a network manager to configure the location of the device.

For an interoperable node the Program ID is used as a Standard Node ID. Standardization of this ID is necessary because it is stored into EEPROM by the

node manufacturer. From a network management view, there needs to be consistency in the semantics of this string.

The following format is used:

Field	**Size**	**Type**	**Assigned by**
format	4 bits	unsigned	Echelon
manufacturer ID	20 bits	unsigned	Echelon
device class	16 bits	unsigned	Echelon
device subclass	16 bits	unsigned	Echelon
model number	8 bits	unsigned	manufacturer

Echelon will assign the first four elements of the Standard Node ID for each interoperable product, and the manufacturer can choose the model number for the fifth element. The Standard Node IDs will be included in the product descriptions in the Interoperable Product Catalog.

This standard node ID will allow network management products to use look up tables for .XIF files.

Guideline: Self-Installing nodes must be configurable by a network manager

The `SNVT_config_src` `"config"` network variable must be used to allow a network manager to override self installation.

5

Summary

The LONWORKS interoperability guidelines are part of Echelon's overall program to ensure LONWORKS technology is the standard for sense and control networks. LONWORKS technology provides the first real opportunity for products made by different manufacturers to interoperate.

These guidelines are intended for LONWORKS developers and will become part of the LONMARK program for endorsing LONWORKS interoperable products. It is anticipated that Administrative guidelines for obtaining the LONMARK logo will be available by 6/92 from Echelon. Products that apply to carry the LONMARK logo will be tested to verify that the product has been designed according to these guidelines. There is a form enclosed for you to request a copy of the LONMARK administrative guidelines once they become available.

There are also forms attached for providing us with feedback on the guidelines covered in this document and additional areas you feel need to be addressed.

LONMARK Program

Name: ______________________

Title: ______________________

Company: ______________________

Address: ______________________

____

____

Please send me the LONMARK Administrative Guidelines as soon as they are available (anticipated 6/92)

❐ Yes

I am designing an interoperable product that I will want to carry the LONMARK logo.

❐ Yes In what timeframe?______________

❐ No

I would like to discuss our interoperable product design.

❐ Yes

❐ No

FAX to: **Paula E. Skokowski**
Echelon Corporation
FAX # 415-856-6153

Name: ______________________________

Title: ______________________________

Company: ______________________________

Address: ______________________________

____

____

Feedback:

Attach additional sheets if needed.

FAX or Mail to:

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